BREEDING OF KENAF THROUGH MUTATION INDUCED BY GAMMA-RAYS AND THERMAL NEUTRONS [1]

M. L. LAI AND JAMES M. DEMPSEY [2]

Kenaf (*Hibiscus cannabinus L.*), the best substitute for jute, is an annual herbacious plant. Its fiber is normally used for the production of hessians, twines and fishing nets. Recent research in the U. S. A. has shown that paper pulp made from mature kenaf stalk has characteristics comparable with or even superior to hardwood and softwood pulps bond paper, speciality paper, fine papers, structural boards and blends with wood pulps. Several different kinds of paper are proposed uses for kenaf.

Some better mutants of kenaf with fewer prickles, resistance to cliological fungi and tolerance to pests and insensiveness to daylight are desired. These characters may be selected from the progenies of seeds treated with radiation which is the most efficient method to improve the qualitative characters of the crops.

Possibly the most serious limitation to the successful of kenaf in the United States is its susceptibility to *Meloidogyne incognita, acrita* and other root-knot nematodes and associated root-rot organisms.

Allohexaploid (2n=108) F and F interspecific hybrids of kenaf-roselle (*Hibiscus cannabinus H. sabdariffa*) were intermediate in their resistance to *M. incognita acrita*, between their moderately resistant tetraploid parent, roselle (*H. sabdariffa* L.), and their susceptible diploid parent, kenaf (*H. cannabinus* L.) (Wilson and Adamson 1970).

U. S. Plant Introduction Station, Savannah, Georgia, is carrying out a task to select the better mutants of kenaf in their resistance to the cotton root-knot nematode (*M. incognita acrita*) from the progenies of seeds treated with radiation. (Lai 1972).

Materials and Methods

By virtue of "gamma ray" and "thermal neutron" produced by 100 KW pooltype "Atomic Reaction Generation" and the "Cobalt 60" furnished by the Atomic Science Institute, the University of Florida, for advanced study, the healthy, mature seeds of kenaf have been treated at various rates listed below :

1. Gamma rays : 200 sterilized seeds of kenaf Everglades 71 with 96% germination were treated at 0 (control) , 5000, 10000, 15000 and 20000 R (as G ck, G_1, G_2, G_3 and G_4, respectively) on July 29 at University of Florida.

2. Thermal neutrons : 200 seeds of Everglades 71 were treated on August 15 with

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1. Serial No. (Q) 631

2. Senior specialist and director, Tainan Fiber Crops Experiment Station, Taiwan Agricultural Research Institute, Tainan, Taiwan, R. O. C. and tropical fiber crops specialist, Department of Agronomy, University of Florida, Gainesville , Florida 32601, U. S. A.

different intensities and duration of thermal neutron as following : 0.6×10^{8}/cm^{2}, 1.2×10^{8}/cm^{2}, 1.8×10^{8}/cm^{2}, 2.7×10^{8}/cm^{2}, 3.6×10^{8}/cm^{2} and 7.2×10^{8}/cm^{2} (as TN_1, TN_2, TN_3, TN_4, TN_5, and TN_6) . Control (TNck) seed with germination were untreated.

I. Field Trials :

Land preparation : Field plots were located on fine sand, University of Florida Experimental Farm, Gainesville, Florida at latitude 29°41′ North. The proceeding crop, the young pea was plowed and rototilled on July 26th and 27th. On July 30th, the field was treated with Nemagon on 36″contours at the rate of 1 gallon per hectare and was embedded. Beds were leveled on August 4th and 36″ rows were Nemagon was applied, were marked. On August 5th, land was staked off for planting. Treatments were arranged at random within each of two replications. Each plot was one row 9 m. long with 10 cm spacing. The distance between rows was 90 cm. On August 6th land is fertilized with 1 cup of organic compounds. On August 9th and 18th, all seeds treated with gamma rays and thermal neutron were sowed respectively. On September 15th, the 2nd application of 2 cups of organic compounds and 1/2 cup of phosphite were made. All seeds treated either with gamma rays or thermal neutron were planted on August 5th and 17th, 1971, respectively. The lst weeding was performed on August 24th, 1971, the 2nd weeding on September 13th and 14th, 1971.

II. Greenhouse Trials

All germinated seeds were planted in plastic boxes in size of 5 cm square at top, 4 cm square at bottom and 5 cm tall, treated with Nemagon. The arenaceous soil was used. One seed was planted to a depth of 10 mm in each box. All seeds treated either with gamma rays or with thermal neutron were planted on August 5th, on 16 th, 1971, respectively. Treatments were replicated four times with five plants in every plots.

On August 19th each plot of the gamma-ray treatments and that of control were fertilized with 20 ml liquer (half teaspoon in two litter of water) first time August 25th gamma rays, thermal neutrons and control each plot were fertilized 20 ml liquer second and first times on August 27th and 28th all treatment and control were moved to seeding bed. On September 2nd each plot of all treatments and control were fertilized with 20ml liquer third and four times.

The growth condition of plants kept in the field as well as in the greenhouse were investigated in every half month, and all plants were harvested December 16th, 1971 and January 16th, 1972, respectively.

Results and Discussion

I. Greenhouse Observations

Plants flowered 11 to 12 weeks after sowing in the greenhouse have been observed. Yet no seeds have been collected from these plants due to the abnormal growth. The results are clearly shown in figure 1 and table 1.

Table 1. Greenhouse trial of kenaf : investigation of growth in M

Sowing date: August 5th (G) or 16th (TN), 1971
Harvesting date: January 16, 1972

Treatment	Germination %	Flowering		No. of plants plant/row					Fresh stem weight g/row				
		Begin	Full bloom	I	II	III	IV	mean	I	II	III	IV	mean
G_1	90	10/28	11/4	5	5	5	—	3.5	136	91	113	—	86
G_2	85	10/28	11/4	5	5	2	2	3.5	91	91	50	45	68
G_3	90	10/28	11/4	5	5	5	2	4.3	91	218	117	41	112
G_4	95	10/28	11/4	5	5	3	1	3.5	113	127	45	5	69
G (ck)	100	10/28	11/4	4	5	4	2	3.8	96	110	91	50	86
TN_1	95	10/28	11/4	3	5	4	2	3.5	18	82	54	41	50
TN_2	95	10/28	11/4	5	5	5	2	4.3	64	82	91	14	64
TN_3	85	—	—	5	5	4	—	3.5	54	82	82	—	41
TN_4	95	10/28	11/4	5	4	2	0	2.8	45	23	23	—	23
TN_5	80	—	11/4	5	5	5	1	4.0	50	96	54	14	54
TN_6	90	—	—	—	—	—	—	—	—	—	—	—	—
TN(ck)	90	—	—	5	3	1	3	3.0	50	45	5	18	23

2. Field Observation

Many plants flowered 10 to 11 weeks after sowing had been carefully observed. Seeds from all these treatments had been collected and results are shown in figure 1 and table 2.

Table 2. Field trials of kenaf : investigation of growth in M_0

Sowing date: Aug. 9-10, 16, 1971
Harvesting date: Jan. 15-16, 1972

Treatment	Germination	Flowering		Plant height m	No. of plants plant/row			Fresh stem weight kg/row			Seeds wt. g/row			Choosed plant
		Begin	Full bloom		I	II	mean	I	II	mean	I	II	mean	
G_1	92	10/20	11/6	2.342	78	82	80	8.67	16.34	12.50	312	465	387	5
G_2	91	10/20	11/6	2.374	86	83	85	13.21	18.16	15.68	346	555	451	5
G_3	96	10/20	11/6	2.139	86	86	86	8.67	19.75	14.20	326	624	475	5
G_4	96	10/20	11/6	2.274	85	86	85	9.76	18.16	13.96	369	479	424	4
Gck	93	10/20	11/6	2.254	82	85	83	13.71	15.66	14.68	343	547	445	—
TN_1	60	—	—	2.037	53	52	52	4.58	7.03	5.80	135	236	186	5
TN_2	65	10/20	11/6	2.300	56	58	57	9.70	6.72	7.86	291	206	249	5

TN_3	71	11/1	11/6	1.951	51	88	69	9.12	6.26	7.69	227	148	188	4
TN_4	65	11/1	11/6	1.811	47	64	55	5.17	4.63	4.90	138	110	124	3
TN_5	68	11/1	11/20	1.328	49	53	51	1.59	3.40	2.49	17	49	33	2
TN_6	35	—	—	—	—	—	—	—	—	—	—	—	—	—
TNck	74	10/20	11/6	2.327	65	68	66	10.62	10.35	10.48	309	401	355	—

The vigours of seedings in different treatments of gamma rays are higher than the check both in the greenhouse and field trials. The treatment at 15000 R is higher than the others. While the plant heights between different treatments are significant at the harvest stage.

In treatments of thermal neutron at $7.2\times10^8/cm^2$ the seedings were all dead in one month after germination both in the greenhouse and in the field trials. It is possible that this intensity and duration of thermal neutron treatment is too high. In the greenhouse trials, the vigours of seeding in treatments of thermal neutrons at $0.6\times10^8/cm^2$, $1.2\times10^8/cm^2$, and $1.8\times10^8/cm^2$ are higher than the check. But the plant heights between different treatments are not significant at the harvest stage.

While in the field trials, the vigours of seedings in different treatments are lower than check. The plant heights in different treatments of gamma ray are significantly higher than check at the harvest stage. The plant height, number of plant, fresh stem weight and seeds weight in different treatments of thermal neutrons are lower than check, but in the treatments of gamma rays at 10,000 R and 15,000 R are higher than the check. The study would be carried out in the future at M_1 and M_2 generation.

Summary

Gamma-irradiation of kenaf seeds of variety Everglades 71, at 5000, 10000, 15000 and 20000 R was investigated as a method of inducing potentially valuable mutants in kenaf. So did the thermal neutron treatments with the different intensities and duration of $0.6\times10^8/cm^2$, $1.2\times10^8/cm^2$, $1.8\times10^8/cm^2$, $2.7\times10^8/cm^2$, $3.6\times10^8/cm^2$ and $7.2\times10^8/cm^2$. Stimulative effects from irradiation were indicated in that seedling vigor and plant height were greater in the M_0 15000 R treatment than in the control. As far as thermal neutron treatments were concerned, there was no great effects on either plant vigor or plant height except the death of all seedings in the NT $7.2\times10^8/cm^2$ treatment.

Variability from interspecific hybridization has been of limited value in applied breeding programs since most of desirable features from other species are frequently linked with undesirable agronomic characters. Success in breaking these associations has not been achieved to date in most instances. Due to the rather limited variability in kenaf and difficulties in using that brought in by hybridization, there is need for other means of increasing variability and studying the potential use of such variability in breeding programs. The study described above was initiated to investigate the effectiveness of gamma- and thermal neutron-irradiation of kenaf seeds in inducing potentially valuable mutants and increasing the variability in quantitative characters.

Acknowledgement

My thanks are to Dr. E. G. Rodgers, professor and Graduate Coodinator of the Agronomy Department, the University of Florida, for arranging the greenhouse and field trials and Dr. N. J. Diaz, asst. prof. of the Nuclear Engineering Sciences, The University of Florida, for treating the kenaf seeds.

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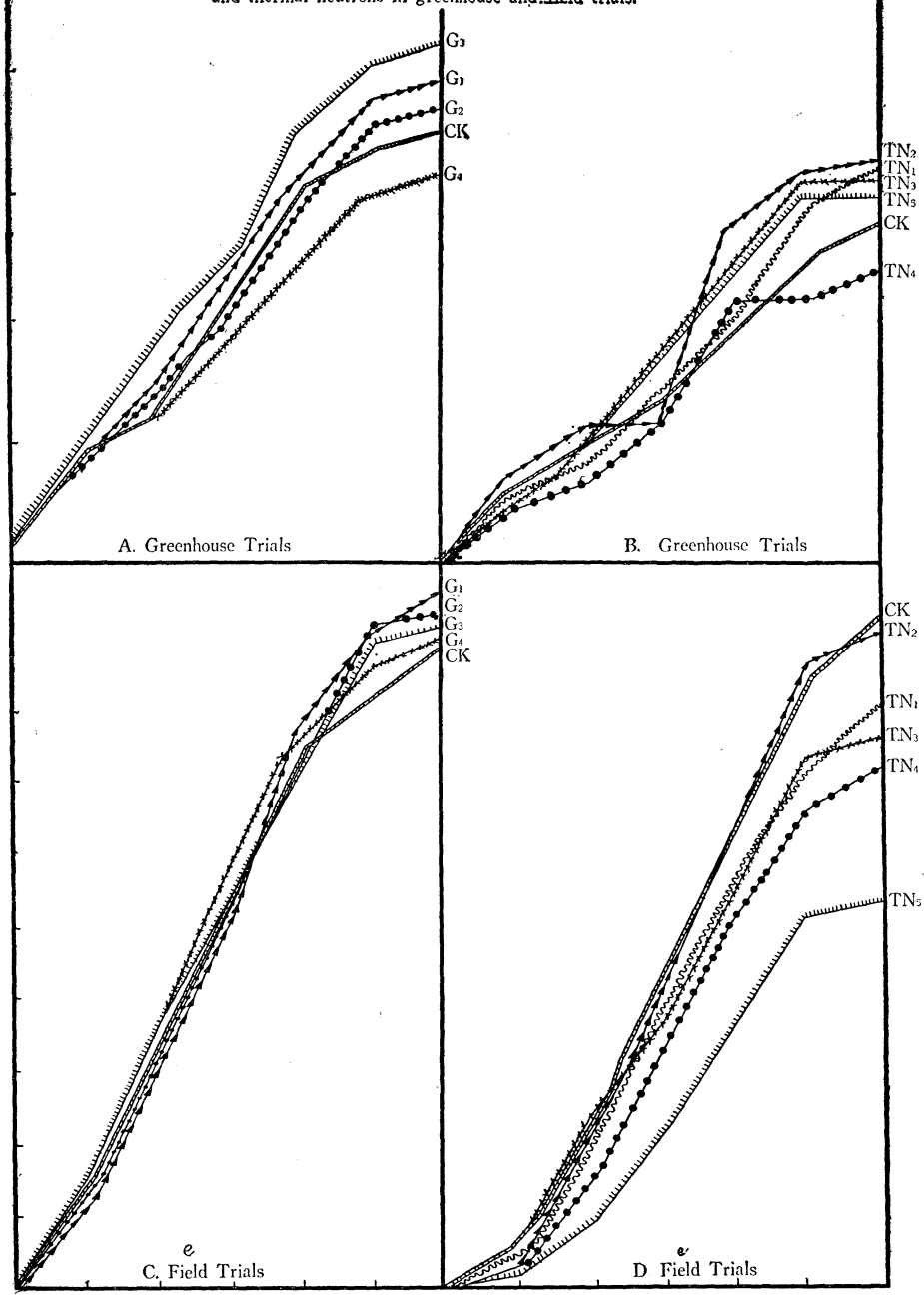
Figure 1. The vigour in Mo between different treatments of gamma rays and thermal neutrons in greenhouse and field trials.



伽瑪線及熱中子處理鐘麻種子誘變育種之研究

賴 銘 立　J. M. Dempsey

本試驗研究於1971年 8 月至1972年 1 月在美國佛羅里達州立大學農業試驗場進行。其目的在探討利用伽瑪線及熱中子處理鐘麻種子進行誘變育種之價值；並比較兩種射線處理鐘麻種子最適當之劑量，期能在後代 Mo 中選拔豐產並具抗根瘤線蟲之品系。茲將試驗結果簡述如下：

一、本試驗以美國佛州推廣栽培之鐘麻品種 Everglade 71爲材料，伽瑪線處理包括5000、10000、15000 及 20000 R 4 種，並以不處理區爲對照；熱中子處理包括 $0.6\times10^{8}/cm^{2}$, $1.2\times10^{8}/cm^{2}$, $1.8\times10^{8}/cm^{2}$, $2.7\times10^{8}/cm^{2}$ 及 $7.2\times10^{8}/cm^{2}$ 6 種，並以不處理區爲對照，分別在玻璃室及田間進行。

二、鐘麻種子經熱中子處理後由 M_0. 之觀察調查，植株高度、收穫株數、鮮株重及採種量恆較未處理之對照區爲低，且照射時間逾長者逾低。$7.2\times10^{8}/cm^{2}$ 處理區由於照射時間過長，萌芽後幼苗相繼枯死。伽瑪線各處理中以 10,000及15,000 R 兩區其植株高度、收穫株數及採種量恆較對照區爲高，各處理區均在田間分別選取生育高大根部無根瘤線蟲感染之優良單株，編號採收蒴果，寄回本分所繼續進行觀察選拔。

三、鐘麻種間雜交，常由於雜交後代細胞染色體發生連鎖現現象而不易獲得具有抗病及優良農藝性狀之品系，利用伽瑪線及熱中子進行誘變育種，期能在誘變後代中選獲豐產、質佳之抗根瘤線蟲之品系。

本文係第一作者在美國進修報告之一部份。

1.試驗報告農試字第六三一號。

2.臺灣省農業試驗所臺南棉麻試驗分所技正兼分所長及美國佛羅里達州熱帶纖維作物專家。